Chapter A12: Threatened & Endangered Species Analysis Methods

INTRODUCTION

Threatened and endangered (T&E) and other special status species can be adversely affected in several ways by cooling water intake structures (CWISs). T&E species can suffer direct harm from impingement and entrainment (I&E), they can suffer indirect impacts if I&E at CWISs adversely affects another species upon which the T&E species relies within the aquatic ecosystem (e.g., as a food source), or they can suffer impacts if the CWIS disrupts their critical habitat.[1] The loss of individuals of listed species from CWISs is particularly important because, by definition, these species are already rare and at risk of irreversible decline because of other stressors.

This chapter provides information relevant to an analysis of listed species in the context of the §316(b) regulation; defines species considered as threatened, endangered, or of special concern; gives a brief overview of the potential for I&E-related adverse impacts on T&E species; and describes methods available for considering the economic value of such impacts.

CHAPTER CONTENTS

A12-1 LISTED SPECIES BACKGROUND

The federal government and individual states develop and maintain lists of species that are considered endangered, threatened, or of special concern. The federal trustees for endangered or threatened species are the Department of the Interior's U.S. Fish and Wildlife Service (U.S. FWS) and the Department of Commerce's National Marine Fisheries Service (NMFS). Both departments are also are referred to herein as the Services. The U.S. FWS is responsible for terrestrial and freshwater species (including plants) and migratory birds, whereas the NMFS deals with marine species and anadromous fish (U.S. Fish and Wildlife Service, 1996a). At the state level, the departments, agencies, or commissions with jurisdiction over T&E species include Fish and Game; Natural Resources; Fish and Wildlife Conservation; Fish, Wildlife and Parks; Game and Parks; Environmental Conservation; Conservation and Natural Resources; Parks and Wildlife; the states' Natural Heritage Programs, and several others.

[1] To simplify the discussion, in this chapter EPA uses the terms "T&E species" and "special status species" interchangeably to mean all species that are specifically listed as threatened or endangered, plus any other species that has been given a special status designation at the state or federal level.

A12-1.1 Listed Species Definitions

a. Threatened and endangered and species

A species is listed as "endangered" when it is *likely to become extinct* within the foreseeable future throughout all or part of its range if no immediate action is taken to protect it. A species is listed as "threatened" if it is *likely to become endangered* within the foreseeable future throughout all or most of its range if no action is taken to protect it. Species are selected for listing based on petitions, surveys by the Services or other agencies, and other substantiated reports or field studies. The 1973 Endangered Species Act (ESA) outlines detailed procedures used by the Services to list a species, including listing criteria, public comment periods, hearings, notifications, time limits for final action, and other related issues (U.S. Fish and Wildlife Service, 1996a).

A species is considered to be endangered or threatened if one or more of the following listing criteria apply (U.S. FWS, 1996):

- the species' habitat or range is currently undergoing or is jeopardized by destruction, modification, or curtailment;
- the species is overused for commercial, recreational, scientific, or educational purposes;
- the species' existence is vulnerable because of predation or disease;
- current regulatory mechanisms do not provide adequate protection; or
- the continued existence of a species is affected by other natural or man-made factors.

b. Species of concern

States and the federal government have also included species of "special concern" to their lists. These species have been selected because they are (1) rare or endemic, (2) in the process of being listed, (3) considered for listing in the future, (4) found in isolated and fragmented habitats, or (5) considered a unique or irreplaceable state resource.

A12-1.2 Main Factors in Listing of Aquatic Species

Numerous physical and biological stressors have resulted in the listing of aquatic species. The major factors include habitat destruction or modification, displacement of populations by exotic species, dam building and impoundments, increased siltation and turbidity in the water column, sedimentation, various point and non-point sources of pollution, poaching, and accidental catching. Some stresses, such as increased contaminant loads or turbidity, can be alleviated by water quality programs such as the National Pollutant Discharge Elimination System (NPDES) or the current EPA efforts to develop Total Maximum Daily Loads (TMDLs). Other factors, such as dam building or habitat modifications for flood control purposes, are relatively permanent and therefore more difficult to mitigate. In addition to these major factors, negative effects of CWISs on some listed species have been documented.

Congress amended the ESA in 1982 and established a legal mechanism authorizing the Services to issue permits to non-federal entities — including individuals, private businesses, corporations, local governments, state governments, and tribal governments — who engage in the "incidental take" of federally-protected wildlife species (plants are not explicitly covered by this program). Incidental take is defined as take that is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity under local, state or federal law." Examples of lawful activities that may result in the incidental take of T&E species include developing private or state-owned land containing habitats used by federally-protected species, or the withdrawal of cooling water that may impinge or entrain federally-protected aquatic species present in surface waters.

An integral part of the incidental take permit process is development of a Habitat Conservation Plan (HCP). An HCP provides a counterbalance to an incidental take by proposing measures to minimize or mitigate the impact and ensuring the long-term commitment of the non-federal entity to species conservation. HCPs often include conservation measures that benefit not only the target T&E species, but also proposed and candidate species, and other rare and sensitive species that are present within the plan area (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 2000). The ESA stipulates the major points that must be addressed in an HCP, including the following (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 2000):

- defining the potential impacts associated with the proposed taking of a federally-listed species;

- describing the measures that the applicant will take to monitor, minimize, and mitigate these impacts, including funding sources;[2]

- analyzing alternative actions that could be taken by the applicant and reasons why those actions cannot be adopted; and

- describing additional measures that the Services may require as necessary or appropriate.

HCP permits can be issued by the Services' regional directors if:

- the taking will be incidental to an otherwise lawful activity,
- any impacts will be minimized or fully mitigated,
- the permittee provides adequate funding to fully implement the permit,
- the incidental taking will not reduce the chances of survival or recovery of the T&E species, and
- any other required measures are met.

The Services have published a detailed description of the incidental take permit process and the habitat conservation planning process (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 2000). The federal incidental take permit program has only limited application within the context of the §316(b) regulation because many T&E species (fish in particular) are listed mainly by states, not by the Services, and hence fall outside of the jurisdiction of this program.

A12-2 Framework for Identifying Listed Species Potentially at Risk of I&E

Evaluating benefits to listed species from the proposed §316(b) regulation requires data on the number of listed organisms impinged and entrained and an estimate of how much the impingement and entrainment of listed species will be reduced as a result of the regulation. Estimating I&E for candidate and listed species presents significant challenges due to the following:

- Most facilities operating CWISs do not monitor for I&E on a regular basis,

- T&E populations are generally restricted and fragmented so that their I&E may be sporadic and not easy to detect by conventional monitoring activities, and

- Entrained eggs and larvae are often impossible to identify to the species level, making it difficult to know the true number of losses of a species of concern.

Some facilities have knowledge about the extent of their impact on T&E species. These facilities require incidental take permits and must develop HCPs (e.g., the Pittsburg and Contra Costa facilities in California, see Part E of this document). Where specific knowledge of I&E rates does not exist, risks to T&E species must be estimated from other information. The remainder of this section discusses EPA's methodology of estimating the numbers of listed species potentially at risk of I&E. The framework involves four main steps (see Figure A12-1).

- Step 1 identifies all state- or federally-listed species for the states that border the CWIS source water body.

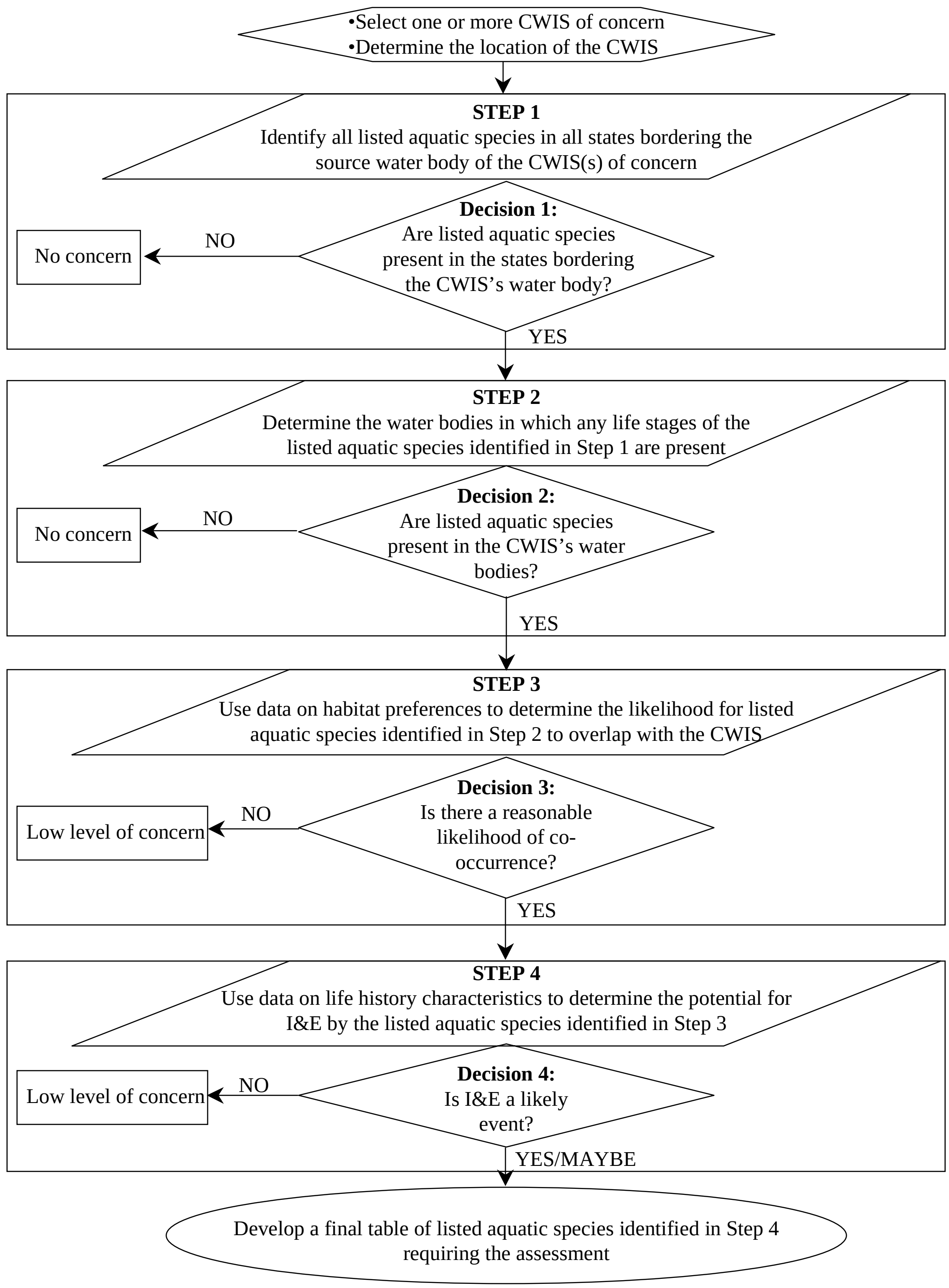
- Step 2 determines if a listed species from Step 1 is present in the vicinity of the CWIS. If a species distribution overlaps with the CWIS, the analysis proceeds to Step 3.

- Step 3 uses information on habitat preferences and site-specific intake structure characteristics to better define the degree of vulnerability of the listed species to the CWIS.

- Step 4, if necessary, further refines the potential for I&E based on the life history characteristics of the listed species.

[2] Mitigation can include preserving critical habitats, restoring degraded former habitat, creating new habitats, modifying land use practices to protect habitats, and establishing buffer areas around existing habitats.

Figure A12-1: Flowchart for Identifying T&E Aquatic Species with a Reasonable Potential for I&E by CWISs



The result of this four-step analysis is a table of listed species that are likely to experience I&E by a CWIS of concern based on their geographic distribution, habitat preferences, and life history characteristics.

A12-2.1 Step 1: Compile a Comprehensive Table of Potentially-Affected Listed Species

The first step in determining the potential for I&E by a CWIS is to identify all state and federally-listed aquatic species in the area of interest. Aquatic species may include fish; gastropods (such as snails, clams, or mussels); crustaceans (such as shrimp, crayfish, isopods, or amphipods); amphibians (such as salamanders, toads, or frogs); reptiles (such as turtles, alligators, or water snakes); and mammals (such as seals or sea lions). The U.S. FWS maintains a web site (http://endangered.fws.gov/endspp.html) on all federally-listed species organized by state or taxonomic group. Because the federal list represents only a small subset of the species listed by individual states, however, the analyst also needs to obtain state lists to develop a comprehensive table of aquatic species potentially affected by the CWISs of concern.[3] Individual state agencies, universities, or local organizations maintain web sites with data on state-listed species. A preliminary search in support of this chapter showed that various agencies have responsibilities for maintaining species lists in different states. The departments, agencies, or commissions with jurisdiction of T&E species include Fish and Game; Natural Resources; Fish and Wildlife Conservation; Fish, Wildlife and Parks; Game and Parks; Environmental Conservation; Conservation and Natural Resources; Parks and Wildlife; and several others. The states' Natural Heritage Programs can also be contacted to request listing information, species-specific data on geographic distributions, and other valuable data. Appendix A1 provides a recent compilation of aquatic T&E species by The Nature Conservancy (TNC). Information on Natural Heritage Programs in the U.S. can be obtained from The Natural Heritage Network at http://www.heritage.tnc.org. A thorough search of these and other relevant sources should be performed to get the data required to identify target species.

If a CWIS of concern is located on a water body confined to one state, then only federally-listed aquatic species found in that state and the aquatic species listed by the state itself need to be considered in the analysis. An example would be the Tampa Bay Estuary, which is entirely contained within the state of Florida. The search should expand if the CWIS is located on a water body that covers more than one state, which may be the case for large lakes, rivers, and estuaries. For example, the watersheds abutting the U.S. side of Lake Erie cover parts of New York, Pennsylvania, Ohio, Indiana, and Michigan. The Delaware River Basin covers parts of Delaware, Pennsylvania, New Jersey, and New York. At a minimum, a table of potentially affected T&E species should include species listed by the state in which the CWIS is located, together with any federally-listed aquatic species in all the states covered by the watershed. A more rigorous approach at this initial stage might be to include all state-listed aquatic species from every state covered by the water body of concern, even if the likelihood is small that a listed species moves beyond the boundaries of the CWIS's state.

The product of this initial step is a table of all the aquatic species listed by the U.S. FWS and the state(s) of interest. The information should be organized by species category — such as fish, amphibians, aquatic invertebrates, aquatic reptiles, and/or aquatic mammals. The information should also include:

- the common and scientific name of each listed species;
- the agency listing the species (state or U.S. FWS, or both); and
- the legal status of the species (threatened, endangered, or of special concern).

The analyst can assume that the CWIS does not have a direct impact on listed species only if no aquatic species are listed as threatened, endangered, or of special concern in the target state(s). The analyst must also determine if there is an indirect impact through the food chain. If not, then no further analysis is required for that CWIS.

A12-2.2 Step 2: Determine the Geographic Distribution of Listed Species

In the second step, the analyst determines if the listed species identified in Step 1 are present in the same water body as the CWIS of concern. This step represents a simple pass-fail decision: a species is retained if the distribution of one or more of its life stages coincides with the water body of interest; it is removed if it does not (see also Figure A12-1).

The analyst can obtain the information required for this step from several sources. Local agencies may have developed "species accounts" for certain federally-listed species. Recovery plans may also be available for some of the federally-listed species. These and other sources may provide information on species ranges, population levels, reproductive strategies, developmental characteristics, habitat requirements, reasons for current status, and/or management and protection needs. When compiling this information, the analyst should look not only at the distribution of adults but also of juveniles,

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[3] As discussed earlier, both T&E species and species of special concern should be included.

particularly if the species is known to migrate between different locations over its life. This step is particularly important for anadromous fish species, but may also apply to other species that have seasonal or life cycle-dependent migrations (for example, adult frogs may live on land but spawn in rivers).

Most listed aquatic species are listed by individual states rather than on a federal level. Data on the federally-listed species are therefore unlikely to suffice for the analysis. States typically post their species list on the Internet. A few states have also developed short species accounts with information on distribution, life history characteristics, habitat requirements, and other useful details. Distribution or range data may consist of specific locations of sightings or catches (for example, particular river miles), general distributions within individual watersheds, or more generic and qualitative descriptions. Some states have also published hardcopy reports with species-specific information that may not be available on the Internet. Finally, the Natural Heritage Programs in numerous states have also developed species-specific data (see Appendix A1). All these materials should be obtained and reviewed during the data gathering process.

Distributional information for some of the T&E species may not be available. The analyst may need to consult secondary sources, such as species atlases (for example, see fish species distributions in the U.S.; or Smith, 1985, for fish distributions in New York State), field guides, published papers, or textbooks. Distributional data may be missing altogether for some of the more obscure species. The lack of such data should not by itself result in the removal an T&E species at this point in the selection process. The analyst should instead look at habitat requirements (Step 3) or life history characteristics (Step 4) before the species is no longer considered of concern to the CWIS under consideration.

The majority of species will be eliminated at this stage because most of the listed aquatic species, with some notable exceptions, tend to have rather fragmented and limited distributions due to extensive habitat loss or narrow habitat requirements. Step 2 produces a table of listed species whose geographic distributions generally overlap with the location of the CWIS.

A12-2.3 Step 3: Compare Habitat Preferences of Listed Species to the CWIS

Step 3 identifies listed species that could be affected by the CWIS of concern through a comparison of their habitat preferences and the location of the CWIS. The potential for I&E exists, and hence the listed species is retained, if the habitat preferences of one or more life stages match the location of the CWIS of concern. If the habitat preferences of no life stages of the listed species match the location of the CWIS, then the species can be removed from further consideration.
The analyst needs to obtain a general description of the location of the CWIS of concern in terms of (1) where the CWIS is found within the water body (e.g., inshore versus off-shore; deep versus shallow; etc.) and (2) the kinds of habitats associated with this general location. Such information may be available from site-specific field observations, permit applications by the facilities, natural resources maps, or other related sources.

a. Location

The presence of a listed species in the water body from which a CWIS withdraws water does not necessarily mean that the species will be impinged or entrained by the intake structure. Two additional variables need to be considered: the habitat preferences of the listed species and the characteristics of the CWIS (location, design, and capacity). The following example highlights the relationship between these two variables:

An endangered darter species is present in a river with a CWIS of concern. All life stages of this species are confined to swift-running, shallow (i.e., less than one foot deep) riffle zones, whereas the CWIS of concern is located many miles downstream in deep areas of the river that are unsuitable darter habitat. The likelihood of impact on the darter by the CWIS is minimal even though both are present within the same water body.

b. Other habitat information

Detailed information on the habitat requirements of the target species is also needed. This information should focus on *all* the life stages, including eggs, larvae, juveniles, and adults, because habitat requirements often vary by life stage. For example, adults of a listed fish species may inhabit deeper waters of large lakes and produce pelagic eggs, but juveniles may be found only in nearshore nursery areas. It would be insufficient to consider only the habitat requirements of adults of this species, particularly if a CWIS of concern was located nearshore.

The U.S. FWS T&E species web page, the web pages of individual states or other organizations, or general reference materials can provide data on the habitat preferences of the listed species. Such information may be qualitative, anecdotal, or missing altogether for obscure T&E species. Not all states have developed accounts for their listed species. T&E species web sites of neighboring states may offer additional information if the target species has a regional distribution and is listed throughout its range. The information base can also be augmented by looking at a closely-related species. The substitute species must share the same general habitat preferences as the target species for the comparison to be valid. The analyst should consult appropriate reference materials to ensure a proper match.

c. Assess whether the overlap between habitat requirements and CWIS location exists

The information on habitat preferences for the listed species is compared to location-specific data on the CWIS of concern. The decision step is a simple pass-fail test: a species is retained if the habitat requirements of one or more of its life stages is likely to coincide with the CWIS of concern; otherwise it is removed. The logic supporting this decision is that I&E is unlikely if all the habitat requirements of the target T&E species do not overlap with the habitat in which the CWIS of concern is located.

The exact habitat cutoff point for eliminating a species outright cannot be defined up front; it will depend not only on the target T&E species but also on site-specific factors tied to the CWIS of concern. Several aquatic habitats, however, can be dismissed out of hand because they are not suitable to support CWISs. These habitats include springs, caves, temporary pools, very small ponds and lakes, and shallow headwater streams and creeks. Target T&E species that spend their entire life cycle in these habitats are unlikely to encounter CWISs and can be removed from further consideration. Habitats that have enough volume to support CWISs, namely large rivers and lakes, large estuaries, and inshore marine areas, are likely to require more analysis.

A12-2.4 Step 4: Use Life History Characteristics to Refine Estimate of I&E Potential or Monitor for Actual I&E of the Listed Species

From this point on, the assessment can go in two different directions (see Figure A12-1): (1) the target species is added to the final table because the data indicate potential for I&E, or because more data are needed to refine the assessment; or (2) the species is excluded from the list because there is a low level of concern.

The data may not be as clear-cut for smaller or less mobile species. The overlap between habitat requirements and the location of a CWIS of concern may not suffice to justify adding a target species to the final table without first considering life history information. The decision to proceed beyond Step 3 will vary on a case-by-case basis: it will depend on the target species, access to additional biological information, and the CWIS of concern. The analyst should focus on finding information that will support the decision to add or eliminate a target species. Additional data may not exist for some of the more obscure listed species. Given the protected status of T&E species, however, EPA recommends using a conservative approach to ensure that species are not accidentally omitted when in fact they should be added to the final table. The species should be retained if doubts persist after Step 3: it can still be removed during more site-specific assessments.

Listed clams in big Midwestern rivers are an example of species which may require further assessment in Step 4. Certain clam species would likely pass Step 2 because their distribution overlaps with the locations of CWISs of concern on major rivers. These clam species may also pass Step 3 if their presence coincided with the general location of one or more CWIS of concern. Yet, it is unclear if they should be added to the final table: a closer look at the clams' life history is required to determine the potential for I&E.

The risk of I&E of adult clams is low because they are sedentary, benthic filter feeders or are firmly attached to the substrate. The risk may increase, however, during the reproductive season. During the reproductive season, males release their sperm into the water column. The sperm are carried downstream by the water current and are captured by feeding female clams. The sperm fertilize the female's eggs, which develop inside her body until they hatch. The larvae are released into the water column and must quickly find and attach themselves to a specific fish host to complete their development.[4] Larval clams die if they fail to find a host. After a period of days to weeks, the larval clams detach themselves from their hosts, drop to the bottom, and bury into the sediment or attach to a solid substrate where they remain for the rest of their lives. The only reasonable chance for clam I&E occurs when a fish host with larval life stages attached to it becomes impinged or entrained by a CWIS of concern. Adding a clam species to the final table would depend on whether or not the following occurs:

[4] Larvae of freshwater clams typically require a very specific fish species to complete their development. Scientists do not always know which fish hosts are required by the T&E river clams.

- the host fish is known to science,
- the host fish is present in the stretch of river containing the CWIS, and
- the habitat characteristics of the host fish match the general location of the CWIS of concern. These decisions can be made only on a case-by-case and species-by-species basis.

The information on life history characteristics for the target T&E species should be carefully reviewed to determine the potential for I&E. Several variables may raise concerns, including migratory behavior, pelagic eggs or larvae, foraging activity, and so on. This information is evaluated in comparison to the location of the CWIS of concern. The decision point in this step is a simple pass-fail test: a species is retained if one or more of its life history characteristics enhances the potential for contact with the CWIS of concern; it is removed if all of its life characteristics are unlikely to result in vulnerability to the CWIS of concern.

A12-3 Identification of Species of Concern at Case Study Sites

The following sections illustrate the use of this procedure for identifying vulnerable special status species. The example is for fish species of the Delaware Estuary, the site of one of EPA's benefits case studies (see Part B of this document).

A12-3.1 The Delaware Estuary Transition Zone

a. Step 1: Identify all state- or federally-listed species for the states that border the water body on which the CWIS is located.

Table A12-1 summarizes information compiled by EPA for fish species in the Delaware Estuary.

Table A12-1: Fish Species Listed as Threatened, Endangered, or of Special Concern (Federal plus PA, NJ, DE, and NY)

Common Name (*Latin Name*)	Federally-Listed Species			State-Listed Species											
				Pennsylvania			New Jersey			Delaware			New York		
	E	T	O[a]	E	T	O[b]	E	T	O[b]	E	T	O[b]	E	T	O[b]
Burbot (*Lota lota*)					X										
Chub, Gravel (*Erimystax x-punctata*)				X										X	
Chub, Silver (*Macrhybopsis storeiana*)													X		
Chub, Streamline (*Erymystax dissimilis*)															X
Chubsucker, Lake (*Erimyzon sucetta*)														X	
Darter, Bluebreast (*Etheostoma Camurum*)					X								X		
Darter, Channel (*Percina copelandi*)					X										
Darter, Eastern Sand (*Ammocrypta pellucida*)					X									X	
Darter, Gilt (*Percina evides*)					X								X		
Darter, Longhead (*Percina macrocephala*)				X										X	
Darter, Spotted (*Etheostoma maculatum*)				X										X	
Darter, Swamp (*Etheostoma fusiforme*)														X	
Darter, Tippecanoe (*Etheostoma tippecanoe*)				X											
Lamprey, Mountain Brook (*Ichthyomyzon greeleyi*)					X										X
Lamprey, Northern Brook (*Ichthyomyzon fossor*)				X											
Lamprey, Ohio (*Ichthyomyzon bdellium*)					X										
Madtom, Mountain (*Noturus eleutherus*)					X										
Madtom, Northern (*notutus stigmotus*)					X										
Mooneye (*Hiodon tergisus*)														X	
Redhorse, Black (*Moxostoma duquesnei*)															X

Table A12-1: Fish Species Listed as Threatened, Endangered, or of Special Concern (Federal plus PA, NJ, DE, and NY) (cont.)

Common Name (*Latin Name*)	Federally-Listed Species			State-Listed Species											
				Pennsylvania			New Jersey			Delaware			New York		
	E	T	O[a]	E	T	O[b]	E	T	O[b]	E	T	O[b]	E	T	O[b]
Sculpin, Deepwater *(Myoxocephalus thompsoni)*													X		
Sculpin, Spoonhead *(Cottus ricei)*													X		
Shiner, Ironcolor *(Notropis chalybaeus)*															X
Shiner, Pugnose *(Notropis anogenus)*													X		
Shiner, Redfin *(Lythrurus umbratilis)*															X
Sturgeon, Atlantic (*Acipenser oxyrhynchus*)					X										
Sturgeon, Lake (*Acipenser fulvescens*)				X										X	
Sturgeon, Shortnose (*Acipenser brevirostrum*)	X			X			X			X			X		
Sucker, Longnose (*Catostomus catostomus*)				X											
Sunfish, Banded *(Enneacanthus obesus)*														X	
Sunfish, Longear *(lepomis megalotis)*														X	
Sunfish, Mud *(Acantharchus pomotis)*														X	
Whitefish, Round *(Prosopium cylindraceum)*													X		
TOTAL	**1**	**0**	**0**	**8**	**10**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**8**	**11**	**5**

[a] Other federally-listed species may include species of special interest or concern, monitored species, candidate species, etc.
[b] Other state-listed species may include rare species, species of special interest, species of concern, candidate species, etc.

Sources: New Jersey Division of Fish and Wildlife (2002); Pennsylvania Department of Conservation and Natural Resources (2002); State of New York, Department of Environmental Conservation (2001); U.S. Fish and Wildlife Service (2000).

b. Step 2: Determine if a species listed in Step 1 is present in the area of the CWIS

After identifying species of concern in the source water body, the next step is to determine if any of these species are present in the vicinity of the CWIS. This step involves consulting local biologists as well as literature sources such as species atlases, field guides, and scientific publications. Table A12-2 summarizes the results of EPA's analysis of the distribution of species of concern in the Delaware River Basin. Results indicate two there are two fish species potentially vulnerable to CWIS in the Delaware Estuary transition zone, Atlantic sturgeon and shortnose sturgeon (highlighted in bold in the table).

Table A12-2: Distribution of Listed Species Identified in Step 1

Species Name	Current Distribution	Found in Delaware River Basin?
Burbot	PA: Lake Erie and headwaters of Allegheny River	NO
Chub, gravel	NY: medium and large-sized streams in the Allegheny basin PA: Allegheny River and French Creek	NY: NO PA: NO
Chub, silver	NY: Lake Erie	NO
Chub, Streamline	NY: Allegheny River drainage	NO
Chubsucker, Lake	NY: the Lake Erie drainage basin and embayments along the southern shore of Lake Ontario	NO
Darter, bluebreast	NY: upper reaches of the Allegheny River drainage basin PA: upper Allegheny River and two of its tributaries, namely Little Brokenstraw Creek and French Creek	NY: NO PA: NO
Darter, channel	PA: Lake Erie and large tributaries, and the upper part of the Allegheny River	NO
Darter, eastern sand	NY: Lake Erie, the Metawee and Poultney Rivers near Lake Champlain, the Saint Regis and Salmon Rivers near Quebec, and the Grasse River PA: Lake Erie and Allegheny basin	NY: NO PA: NO

Table A12-2: Distribution of Listed Species Identified in Step 1 (cont.)

Species Name	Current Distribution	Found in Delaware River Basin?
Darter, gilt	NY: found only in the Allegheny River PA: Upper Allegheny River	NY: NO PA: NO
Darter, longhead	NY: Allegheny River and a few of its large tributaries; French Creek PA: Scattered sites in the Allegheny River and French Creek headwaters	NY: NO PA: NO
Darter, spotted	NY: French Creek PA: upper Allegheny River and French Creek	NY: NO PA: NO
Darter, swamp	NY: eastern two-thirds of Long Island	NY: NO
Darter, tippecanoe	PA: upper Allegheny River and French Creek	PA: NO
Lamprey, mountain brook	NY: French Creek and Allegheny River tributaries PA: moderate to large streams of the upper Allegheny River system	NY: NO PA: NO
Lamprey, northern brook	PA: Conneaut Creek in Crawford County in north west PA	NO
Lamprey, Ohio	PA: moderate to large streams of the upper Allegheny River system	NO
Madtom, mountain	PA: French Creek in Mercer and Erie Counties in north west PA	NO
Madtom, northern	PA:French Creek	NO
Mooneye	NY: Lake Champlain, Black Lake, Oswegatchie River, Lake Erie, Saint Lawrence River, and the mouth of Cattaraugus Creek	NO
Redhorse, black	NY: Lake Ontario (likely extirpated) and Lake Erie drainage basins, and the Allegheny River	NO
Sculpin, deepwater	NY: Lakes Erie and Ontario	NO
Sculpin, spoonhead	NY: historically found in Lakes Erie and Ontario but believed to be extirpated	NO
Shiner, ironcolor	NY: Basher Kill and Hackensack River	NO
Shiner, pugnose	NY: Sodus Bay and Saint Lawrence River	NO
Shiner, redfin	NY: drainages of Lakes Erie and Ontario in western NY	NO
Sturgeon, Atlantic	PA: Delaware Estuary	**YES**
Sturgeon, Lake	NY: Saint Lawrence River, Niagara River, Oswegatchie River, Grasse River, Lakes Ontario & Erie, Lake Champlain, Cayuga Lake, Seneca & Cayuga canals PA: Lake Erie	NY: NO PA: NO
Sturgeon, shortnose	DE: Tidal Delaware River NJ: Tidal Delaware River NY: Lower portion of the Hudson River PA: Tidal Delaware River	**DE, NJ, PA: YES** NY: NO
Sucker, longnose	PA: Youghiogheny River headwater streams in south west PA	NO
Sunfish, landed	NY: Passaic River drainage and in eastern Long Island in the Peconic River drainage	NO
Sunfish, longear	NY: Tonawanda Creek	NO
Sunfish, mud	NY: Hackensack River	NO
Whitefish, round	NY: scattered lakes throughout the state	NO

Sources: New Jersey Division of Fish and Wildlife (2002); Pennsylvania Department of Conservation and Natural Resources (2002); Smith (1985); State of New York, Department of Environmental Conservation (2001).

c. Step 3: Use information on habitat preferences and intake location to better define the degree of overlap between listed species and the CWIS

Step 3 involves determining the habitat preferences and life history requirements of species identified in step 2. In Step 2 EPA determined that two fish species of concern are potentially vulnerable to CWIS in the Delaware Estuary transition zone, Atlantic sturgeon and shortnose sturgeon. The habitat preferences and life histories of these species are summarized in Table A12-3.

Table A12-3: Habitat Preferences and Life Histories of Listed Species Identified in Step 2

Species Name	Current Distribution	Habitat Preferences	Potential of overlap w/ CWIS?	Life History	Potential for I&E?	Life Stages Susceptible to I&E?
sturgeon, atlantic	Delaware estuary	estuarine and riverine bottom habitats of large river systems	YES	adults stay in the ocean but move into estuaries and large rivers to spawn in deep water (> 10m deep); eggs sink and stick to the bottom; juveniles make seasonal migrations between shallower areas (summer) and deeper areas (winter) of their birth rivers; juveniles move to the ocean at age 4-5 to mature	YES	larvae and juveniles
sturgeon, shortnose	tidal Delaware River (mostly in the upper and transitional estuary)	estuarine and riverine bottom habitats of large river systems	YES	adults stay in nearshore marine habitats but move in estuaries and large rivers to spawn; eggs sink and stick to the bottom; juveniles make seasonal migrations between shallower areas (summer) and deeper areas (winter) of their birth rivers; juveniles move out to the ocean at age 4-5 to mature	YES	larvae and juveniles

d. Step 4: Use of monitoring or life history characteristics to refine estimate of I&E

In some cases I&E or waterbody monitoring data may be available to estimate CWIS impacts on T&E species. However, in many cases, it will be necessary to estimate relative risk based on waterbody monitoring of the species distribution relative to CWIS and life history and facility characteristics that influence a species vulnerability to I&E.

For the Delaware Estuary example discussed here, there are only limited data available for shortnose sturgeon (Masnik and Wilson, 1980) and Atlantic sturgeon (Shirey et al., 1997) from monitoring in the vicinity of transition zone CWIS. In the case of shortnose sturgeon, 1980 monitoring results indicate that the species is not vulnerable to transition zone CWIS. However, because the data are over 20 years old, further information is needed to confirm that the potential for I&E of shortnose sturgeon remains low. An analysis of life history information indicates that spawning takes many miles upstream of transition zone CWIS, and therefore the risk of entrainment of eggs and larvae is minimal (Masnik and Wilson, 1980). Impingement is also unlikely because salinity and feeding conditions in the transition zone are unfavorable for impingeable-sized juveniles and adults (Masnik and Wilson, 1980).

In the case of Atlantic sturgeon, monitoring in the transition zone indicates that young Atlantic sturgeon occur in the vicinity of the Hope Creek and Salem facilities in the summer months. Data also suggest that Atlantic sturgeon move back downstream in fall, although use of the lower estuary (Delaware Bay) remains unknown (Shirey et al., 1997). This information suggests that Atlantic sturgeon are potentially at risk to transition zone CWIS and indicates the need for I&E monitoring to confirm the degree of harm.

A12-4 Benefit Categories Applicable for Impacts on T&E Species

Once a T&E species has been identified as vulnerable to a CWIS, special considerations are necessary to fully capture the benefits of reducing I&E of the species. The benefits case study presented in Part E of this document illustrates some of the challenges in assigning economic value to T&E species and presents a valuation approach that may prove useful in other cases.

Estimating the economic benefits of helping to preserve T&E and other special status species, such as by reducing I&E impacts, is difficult due to a lack of knowledge of the ecological role of different T&E species and a relative paucity of economic studies focusing on the benefits of T&E preservation. Most of the wildlife economic literature focuses on recreational use benefits that may be irrelevant for valuation of T&E species because T&E species (e.g., the delta smelt in California) are not often targeted by recreational or commercial fishermen. The numbers of special status species that are recreationally or commercially fished (e.g., shortnose sturgeon in the Delaware Estuary) have been so depleted that any use estimates associated with angling participation or landings data for recent years (or decades) would not be indicative of the species' potential value for direct use if and when the population recovers. Nevertheless, there are some T&E species for which consumptive use-related benefits could be significant once the numbers of individuals are restored to levels that enable resumption of relevant uses.

Based on their potential uses, T&E species can be divided into three broad categories:

- *T&E species with high potential for consumptive uses.* The components of total value of such species are likely to include consumptive, non-consumptive, and indirect use values, as well as existence and option values. Pacific salmon, a highly prized game species, is a good example of such species. In addition to having a high consumptive use value, this species is likely to have a high non-consumptive use value. People who never go fishing may still watch salmon runs. The user value may actually dominate the total economic value of enhancing a T&E fish population for species like salmon. For example, Olsen et al. (1991) found that users contribute 65 percent to the total regional WTP value ($171 million in 1989$) for doubling the Columbia River salmon and steelhead runs. Nonusers with zero probability of participation in the sport fishery contribute 25 percent. Nonusers with some probability of future participation contribute the remaining ten percent.

- *T&E species that do not have consumptive uses, but are likely to have relatively large non-consumptive and indirect use values.* The total value of such species would include non-consumptive use and indirect values, and existence and option values. Loggerhead sea turtles can represent such species. The non-consumptive use of loggerhead sea turtles may include photography or observation of nesting or swimming reptiles. For example, a study by Whitehead and Blomquist (1992) reports that the average subjective probability that North Carolina residents will visit the North Carolina coast for non-consumptive use recreation is 0.498. Policies that protect loggerhead sea turtles may therefore enhance individual welfare for a large group of participants in turtle viewing and photography.

- *T&E species whose total value is a pure non-use value*. Some prominent T&E species with minimal or no use values may have high non-use values. The bald eagle and the gray whale are examples of such species. Conversely, many T&E species with little or no use value are not well known or of significant public interest and therefore their non-use values may be difficult to elicit.. Most obscure T&E species, which may have ecological, biological diversity and other non-use values, are likely to fall into this category.

Non-use motives are often the principal source of benefits estimates for T&E species because many T&E species fall into the "obscure species" group. As described in greater detail in Chapter A9, motives often associated with non-use values held for T&E species include bequest (i.e., inter-generational equity) and existence (i.e., preservation and stewardship) values. These non-use values are not necessarily limited to T&E species, but I&E-related adverse impacts to these unique species would be locally or globally irreversible, leading to extinction being a relevant concern. Irreversible adverse impacts on unique resources are not a necessary condition for the presence of significant non-use values, but these attributes (e.g., uniqueness; irreversibility; and regional, national, or international significance) would generally be expected to generate relatively high non-use values (Carson et al., 1999; Harpman et al., 1993).

A12-5 Methods Available for Estimating the Economic Value Associated with I&E of T&E Species

Estimating the value of increased protection of T&E species from reducing I&E impacts requires the following steps:

- Estimating I&E impacts on T&E species; and
- Attaching an economic value to changes in T&E status from reducing I&E impacts on species of concern (e.g., increasing species population, preventing species extinction, etc.)

A12-5.1 Estimating I&E Impacts on T&E Species

Several cases of I&E of federally-protected species by CWIS are documented, including the delta smelt in the Sacramento-San Joaquin River delta, sea turtles in the Delaware Estuary and elsewhere (NMFS, 2001e), and shortnose sturgeon eggs and larvae in the Hudson River (New York State Department of Environmental Conservation, 2000). Mortality rates vary by species and life stage: it is estimated to range from two to seven percent for impinged sea turtles (NMFS, 2001e), but mortality can be expected to be much higher for entrained eggs and larvae of the shortnose sturgeon and other special status fish species. The estimated yearly take of delta smelt by CWISs in the Sacramento-San Joaquin River Delta led to the development of a Habitat Conservation Plan as part of an incidental take permit application (Southern Energy Delta LLC, 2000).

A12-5.2 Economic Valuation Methods

Valuing impacts on special status species requires using nonmarket valuation methods to assign likely values to losses of these individuals. The fact that many of these species typically are not commercially or recreationally harvested (once they are listed) means no market value can be placed on their consumption. Benefits estimates are therefore often confined to non-use values for special status species. The total economic value of preserving species with potentially high use values (i.e., T&E salmon runs) should include both use and non-use values. Economic tools allowing estimates of both use and non-use values (e.g., stated preferences methods) may be suitable for calculating the benefits of preserving T&E species. The relevant methods are briefly summarized below.

It is necessary to note that the benefits of preserving T&E species estimated to date reflect a human-centered view; benefit cost analysis may not be appropriate when T&E species are involved because extinction is irreversible.

a. Stated preferences method

As described in Chapter A9, the only available way to directly estimate non-use values for special status species is through applying stated preference methods, such as the contingent valuation method (CVM). This method relies on statements of intended or hypothetical behavior elicited though surveys to value species. CVM has sometimes been criticized, especially in applications dating back a decade or more, because the analyst cannot verify whether the stated values are realistic and absent of various potential biases. CVM and other stated preference techniques (including conjoint analysis) have evolved and improved in recent years, however, and empirical evidence shows that the method can yield reliable (and perhaps even conservative) results where stated preference results are compared to those from revealed preference estimates (e.g., angling participation as observable behavior) (Carson et al., 1996).

Regardless of the debates over whether or not stated preference methods such as the CVM can generate reliable estimates of non-use values, EPA cannot apply this approach to the 316(b) rulemaking because the time and cost associated with conducting the necessary primary research is well beyond the budget and schedule available to the Agency. Such research also requires that the survey questionnaire and sampling design be reviewed and approved by OMB to comply with the Paperwork Reduction Act. The cost, time requirements, and administrative burdens associated with implementing a valuation survey in accordance with Paperwork Reduction Act create significant additional barriers to the potential for EPA implementing such relevant and useful research.

b. Benefits transfer approach

Using a benefit transfer approach may be a viable option in some cases. By definition, benefits transfer involves extrapolating the benefits findings estimated from one analytic situation to another situation(s). The initial analytic situation is defined in terms of an environmental resource (e.g., T&E species), the policy variable(s) (e.g.,changes in species status or population), and the benefitting populations being investigated. Only in ideal circumstances do the environmental resource and policy variables of the original study very closely match those of the analytic situation to which a policy or regulatory analyst may wish to extrapolate study results. Despite discrepancies, this approach may provide useful insights into benefits to society from reducing stress on T&E species.

The current approach to benefit transfers most often focuses on the meta analysis of point estimates of the Hicksian or Marshalian surplus reported from original studies. If, for example, the number of candidate studies is small and the variation of characteristics among the studies is substantial, then meta analysis is not feasible. This is likely to be the case when T&E species are involved, requiring a more careful consideration of analytic situations in the original and policy studies. If only one or a few studies are available, an analyst evaluates their transferability based on technical criteria developed by Desvouges (1992).

The analyst first identifies T&E species affected by I&E and the type of environmental change resulting from reducing I&E impacts on T&E species, and then selects from a pool of available studies the appropriate WTP values for protecting those species. EPA illustrated the value to society of protecting T&E species by conducting a review of the contingent valuation (CV) literature that estimates WTP to protect those species. This review focused on those studies valuing those aquatic species that may be at risk of I&E by CWISs. EPA also identified studies that provide WTP estimates for fish-eating species, i.e., the bald eagle and the whooping crane. These species may also be at risk because they rely to some degree on aquatic organisms as a food source. Table A12-4 lists the 13 relevant CV studies that EPA identified and provides corresponding WTP estimates and selected study characteristics.

The identified valuation studies vary in terms of the species valued and the specific environmental change valued. Twelve of these studies represent a total of 15 different species. In addition one study (Walsh et al., 1985) estimates WTP for a group of 26 species. Most of these studies value prominent species well known by the public, such as salmon. The studies valued one of the following general types of environmental changes:

- avoidance of species loss/extinction,
- species recovery/gain,
- acceleration of the recovery process,
- improvement of an area of a species' habitat, and
- increases in species population.

The value of preserving or improving populations of T&E species reported in T&E valuation studies has a wide range. Mean household WTP estimates of obscure aquatic species range from $7.20 for the striped shiner (Boyle & Bishop, 1987) to $10.03 for the squawfish (Cummings et al., 1994).

WTP values are low compared with estimates of other prominent fish species, which range from the relatively low estimate of $8.69 (Stevens et al., 1991), to $33.24 (Stevens et al., 1991); both values are mean non-user WTP for Atlantic salmon. WTP estimates for the two fish-eating species, the whooping crane and the bald eagle, both of which have high non-use values (i.e., existence value), range from $18.35 to $303.44 (Loomis and White, 1996). It may be possible to develop individual WTP ranges for a given species or species group based on the estimated changes in T&E status (e.g., species gain or recovery) from reducing I&E impacts and the applicable WTP values from existing studies.

Once individual's WTP for protecting T&E species or increasing their population is developed the next step is the estimation of total benefits from reducing I&E of the special status species. The analyst should apply the estimated WTP value to the relevant population groups to estimate the total value of improving protection of T&E species. The affected population may include both potential users and non-users, depending on species type. The relevant population may also include area residents, regional population, or, in exceptional cases (e.g., bald eagle), the U.S. population. The total value of improved protection of T&E species (e.g., preventing extinction or doubling the population size) should be then adjusted to reflect the percentage of cumulative environmental stress attributable to I&E.

Table A12-4: WTP ($2000) for Improving T&E Species Populations

Species Type	Reference	Publication Date	Survey Date	Species	Environ-mental Change	Size of Change	Annual Mean WTP ($2000)	CVM method	Survey Region	Sample Size	Response Rate	Payment Vehicle
Aquatic	Boyle & Bishop	1987	1984	Striped shiner	Avoid loss	100%	$7.20	DC	WI households	365	73%	Foundation
	Carson et al.	1994	1994	Kelp Bass White Croaker Bald Eagle	Speed recovery from 50 to 5 years		$75.36[a]	DC	CA households	2810	73%	One-time tax
	Cummings et al.	1994	1994	Squawfish	Avoid loss	100%	$10.03	OE	NM	921	42%	Increase state taxes
	Duffield & Patterson	1992	1992	Arctic grayling	Improve 1 of 3 rivers		$20.69[a]	PC	US visitors	157	27%	Trust fund
				Cutthroat Trout			$15.52[a]	PC	US visitors	170	77%	Trust fund
	Kotchen & Reiling	1999	1997	Shortnose Sturgeon	Recovery to self-sustaining population		$28.57[a]	DC	Maine residents (random)	635	63%	One-time tax
	Loomis & Larson	1994	1991	Gray Whale	Gain	50%	$20.44	OE	CA households	890	54%	Protection fund
					Gain	100%	$22.92	OE	CA households	890	54%	Protection fund
					Gain	50%	$31.58	OE	CA visitors	1003	72%	Protection fund

Table A12-4: WTP ($2000) for Improving T&E Species Populations (cont.)

Species Type	Reference	Publication Date	Survey Date	Species	Environ-mental Change	Size of Change	Annual Mean WTP ($2000)	CVM Method	Survey Region	Sample Size	Response Rate	Payment Vehicle
Aquatic (cont.)	Loomis & Larson (cont.)	1994	1991	Gray Whale	Gain	100%	$37.55	OE	CA visitors	1003	72%	Protection fund
	Olsen et al.	1991	1989	Pacific Salmon and Steelhead	Gain (existence value)	100%	$37.29	OE	Pac. NW household	695	72%	Electric bill
					Gain (user value)	100%	$105.35	OE	Pac. NW anglers	482	72%	Electric bill
	Stevens et al.	1991	1989	Atlantic salmon	Avoid loss	100%	$8.69[b]	DC	MA households	169	30%	Trust fund
				Atlantic salmon	Avoid loss	100%	$9.65[b]	OE	MA households	169	30%	Trust fund
	Stevens et al.	1994	1993	Atlantic salmon	Gain	50%	$23.15[b]	DCOE	College students	76	93%	Contri-bution
				Atlantic salmon	Gain	90%	$33.24[b]	DCOE	College students	76	93%	Contri-bution
	Walsh et al.	1985	1985	26 species in CO	Avoid loss	-100%	$69.12	OE	CO households	198	99%	Taxes
	Whitehead	1991, 1992	1991	Sea turtle	Avoid loss	100%	$15.48[a]	DC	NC households	207	35%	Preservation fund

Table A12-4: WTP ($2000) for Improving T&E Species Populations (cont.)

Species Type	Reference	Publication Date	Survey Date	Species	Environ-mental Change	Size of Change	Annual Mean WTP ($2000)	CVM Method	Survey Region	Sample Size	Response Rate	Payment Vehicle
Fish-eating Birds	Bowker & Stoll	1988	1983	Whooping crane	Avoid loss	100%	$37.91	DC	TX and US visitors	316	36%	Foundation
				Whooping crane	Avoid loss	100%	$59.49	DC	TX and US visitors	254	67%	Foundation
	Boyle & Bishop	1987	1984	Bald eagle	Avoid loss	100%	$18.35	DC	WI households	365	73%	Foundation
	Carson et al.	1994	1994	Bald eagle Kelp bass White Croaker	Speed recovery from 50 to 5 years		$75.36[a]	DC	CA households	2810	73%	One-time tax
	Stevens et al.	1991	1989	Bald eagle	Avoid loss	100%	$39.25	DCOE	NE households	339	37%	Trust fund
				Bald eagle	Avoid loss	100%	$27.65	DCOE	NE households	339	37%	Trust fund
	Swanson	1993	1991	Bald eagle	Increase in populations	300%	$303.44[a]	DC	WA visitors	747	57%	Membership fund
				Bald eagle	Increase in populations	300%	$212.55[a]	OE	WA visitors	747	57%	Membership fund

[a] Value is a lump sum.
[b] Annual payment in 5-year program.
Sources: Table adapted from Loomis & White, 1996; CPI: U.S. Bureau of Labor Statistics, Division of Consumer Prices and Price Indexes, 2001.

c. Revealed preference — Cost of T&E species restoration

For the case study analyses, EPA pursued an innovative alternative to infer societal WTP to preserve T&E species. This alternative approach relies on actual sums of money dedicated to restoring special status species as an indication of societal revealed preference to preserve and protect these species. Program costs devoted to habitat restoration in aquatic ecosystems with a comprehensive program to restore special status species fish populations can be used as an indicator of societal WTP for restoring those species. Restoration programs and/or use restrictions designed to help reduce losses of T&E species (or in other ways help to restore and preserve the species) indicate a societal revealed preference to incur costs in order to achieve this goal.

Each individual of a T&E species is important; the restoration costs can therefore be divided by the number of individuals the program is intended to protect or add to the baseline (depleted) population. This action yields a revealed preference value per individual fish. The analyst can then apply these values to the numbers of T&E individuals adversely impacted by I&E. The extent to which this method is a true indicator of societal WTP for species restoration depends on the extent to which the allocation of resources through the political process reflects the true needs for habitat restoration and the extent to which the political process allows for public input. To the extent that the program costs reflect true needs and allows for public input, this method may thus reflect non-use (and any applicable use) values for special status species. Costs incurred to protect and/or restore aquatic special status species reflect a revealed preference by society; the value of the effort is deemed to exceed the costs incurred.

A12-6 Issues in the Application of the T&E Valuation Approaches

Several technical and conceptual issues are associated with valuing I&E impacts on T&E species:

- issues associated with estimating I&E contribution to the cumulative impact from several stressors; and
- issues associated with implementing an economic valuation approach.

A12-6.1 Issues in Estimating Environmental Impacts from I&E on Special Status Fish

Difficulties in estimating the number of individuals or size of the population of special status fish present in a given location are often very difficult for numerous reasons including the following.

- the act of monitoring a T&E species is problematic in and of itself because monitoring generally results in some harm to the species so researchers and federal agencies are reluctant to do it;

- monitoring programs typically focus only on commercially harvested species;

- the number of individuals may be so low that they rarely/never show up in monitoring programs for other species;

- there is often a lack of complete knowledge of the life cycles of special status fish species contributes to an inability to accurately estimate population sizes for some species.

Deriving population estimates from existing monitoring programs often means extrapolating sampling catches to the population as a whole. The variance in estimates is likely to be very high. Several assumptions must be assessed when extrapolating sample catches to population estimates:

- fish are completely recruited and vulnerable to the gear (i.e., are large enough to be retained by the mesh and do not preferentially occupy habitats not sampled) or selectivity of the gear by size is known;

- sampling fixed locations for species approximates random sampling that approximates a stratified random sampling scheme;

- species are uniformly distributed through the water column;

- volume filtered by trawls can be accurately estimated; and

- volumes of water can be estimated for each embayment in the habitat range for the species.

a. Issues in using a benefits transfer approach

The following issues may arise in developing a benefit transfer approach:

- *Some studies estimated WTP for multiple species.* In this review of T&E species studies, values established by Carson et al. (1994), Olsen et al. (1991) and Walsh et al. (1985) value groups of T&E species and therefore transferring values from this studies may not be feasible unless the group of species affected by I&E is the same as the group of species valued in the original studies,.

- The type of *environmental change* valued in the study may not provide a good match to the changes resulting from reducing I&E impacts. As noted above, T&E valuation studies addressed one of the following qualitative changes in T&E status:

  - avoidance of species loss/extinction
  - species recovery/gain
  - acceleration of the recovery process
  - improvement of an area of a species' habitat
  - increases in species population

  The environmental change resulting from reduced I&E effects on T&E species may not match the scenarios considered in the original studies.

- The *size of the environmental change* that the hypothetical scenario defines is also vital for developing WTP estimates. Several studies describe programs that avoid the loss of a species. This outcome may be considered a 100 percent improvement with respect to the alternative, extinction, but the restoration of a species or the increase in population may be specified at any level (e.g. 50 percent, 300 percent, etc.). Swanson estimated a 300 percent *increase* in bald eagle populations and Boyle and Bishop estimated WTP to avoid the possibility of bald eagle *extinction* in Wisconsin (cited in Loomis and White, 1996). Although avoiding extinction may be considered a 100 percent improvement, this environmental change is not comparable with the 300 percent increase in existing populations; preventing regional extinction is quite different than realizing a nominal increase in species population (in which the alternative is not necessarily species loss).

- Although a considerable amount of CV literature has valued T&E species, such research is largely limited to species with high consumptive use or non-use values. They either have high recreational or industrial value, or are popularly valued as significant species for various reasons (e.g., national symbol, aesthetics). Many T&E species that are likely to be affected by I&E (either federal-or state-listed) are obscure and WTP for their preservation has not been estimated.

b. Cost of restoration approach

The issues associated with using habitat restoration costing as an indication of societal revealed preference to preserve T&E species are illustrated in the San Francisco Bay case study (Part E of this document), in which EPA applied this innovative approach. These issues are also discussed in Chapter A11 in Part A of this document, which details the habitat-based restoration cost (HRC) method, applied in the case studies of Brayton Point (Part F), Pilgrim (Part G), J.R. Whiting(Part H), and Monroe (Part I). Issues in the restoration costing approach can generally be divided into three groups:

- "Restoration" programs need not be relied upon exclusively to infer societal revealed WTP to preserve special status species. In many instances, other programs or restrictions are used in lieu of (or in conjunction with) restoration programs, and the costs associated with the non-restoration components also reveal a WTP. For example, efforts to preserve fish species in the San Francisco Estuary area also include water use restrictions that reduce the amount of fresh water diverted from the upstream portion of the Sacramento River to highly valued water uses in the central and southern parts of California. The foregone use values of these waters in agricultural and municipal applications are an important component of the cost society bears to protect and preserve special status species, such as the delta smelt.

- Costs directed at a special species must be isolated from program elements intended to address other species or problems. For example, in a multifaceted restoration or use restriction program, the percentage of costs used mainly to target restoration of special status species fish as opposed to other ecosystem benefits needs to be estimated.

- Estimates must be developed of the change in fish numbers associated with the program. A habitat restoration program may set population targets for restoration of special status fish species, but might not target a specific population size. Often targets are set to abundance levels that existed before a significant decline in populations. If the program has set a population target for restoration of the fish species involved, then the number of fish needed to reach the restoration target can be divided into the relevant portion of program costs to calculate a dollar per fish indicator of the value society places on restoring special status species fish. This per fish value can be used to assess damages for fish species that are not valued commercially or recreationally.

A12-7 CONCLUSIONS

T&E species may be adversely impacted by I&E. To the extent that the proposed rule reduces these adverse impacts, there may be appreciable benefits of reducing stresses on these species of special concern.

Estimating the benefits of reducing the adverse impacts of I&E on special status species often requires a focus on non-use benefits. Use-related benefits for these species may not be relevant (e.g., for fish not targeted by recreational or commercial anglers) or may be misconstrued as minimal based on recent data (e.g., because the reduced numbers of these species have led to long-standing fishing restrictions or such reduced catches that recent period use data are not informative).

Estimating non-use values for T&E species (or other species) is difficult for many reasons. WTP estimates can be derived only from stated preference methods; this line of primary research is not feasible for the Agency to pursue given the cost, time, and administrative requirements of a survey effort. Use of the benefits transfer approach is limited to only those species for which economic valuation studies exist. In some cases, existing restoration programs may serve as a basis for inferring benefits from reducing stresses on special status species if such a program exists. EPA pursued an approach for its case study analysis of T&E species that relies largely on restoration programs to infer revealed preferences by society to incur costs to preserve special status species (see Part E for a detailed example).